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PROVISIONAL APPLICATION FOR PATENT COVER SHEET

This is a requ st for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

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INVENTOR(S)

Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
Brad	LOVETT	West Bloomfield, MI

☑ *Additional inventors are being named on the* 1 *separately numbered sheets attached hereto*

TITLE OF THE INVENTION (280 characters max)

POLYPHTHALAMIDE TUBING FOR AUTOMOTIVE APPLICATIONS

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ENCLOSED APPLICATION PARTS ***(check all that apply)***

☑ Specification *Number of Pages* 9

☑ Drawing(s) *Number of Sheets* 4

☐ Application Data Sheet. See 37 CFR 1.76

☐ CD(s), Number

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Respectfully submitted,

SIGNATURE Karin Butchko

Date 02 / 06 / 04

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REGISTRATION NO. *(if appropriate)* 45,864

Docket Number: 60158-242

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Applicant:	Lovett
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Attorney Docket No.:	60158-242

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POLYPHTHALAMIDE TUBING FOR AUTOMOTIVE APPLICATIONS

BACKGROUND OF THE INVENTION

[1] This invention relates generally to a polyphthalamide tubing for use in automobiles.

[2] Automobiles utilize various types of tubes. The type of tube depends on the operating environment of the automobile system.

[3] Rubber tubes are commonly used in vacuum brake systems, routing from the engine to the vacuum brake booster. The vacuum brake tubing must be capable of withstanding the elevated temperatures of the vacuum brake system and must be resistant to fuel vapor. Radiator systems also utilize rubber tubes for handling water-glycol coolant. Rubber tubes in the radiator system must be capable of withstanding the elevated temperatures of the radiator system while in contact with the water-glycol coolant.

[4] A conventional rubber tube usually includes several layers of rubber with fiber reinforcements in between each layer to provide strength and durability. Rubber tubes are commonly produced by extruding an inner rubber layer over a mandrel. The fiber reinforcements are braided around the outside of the inner layer and an outer rubber layer is extruded over the fiber reinforcements. Additional fiber reinforcements and rubber layers may be applied as necessary. The entire tube is then cured in a curing process. A drawback to this process is that it is laborious and expensive.

[5] Thermoplastic tubes are used in fuel systems. Fuel tubes must be capable of withstanding the elevated temperatures associated with the fuel system while in contact with fuel. Fuel tubes are usually formed from a thermoplastic material such as polyamide, fluoropolymer, or ethylene vinyl alcohol. A drawback of polyamide and ethylene vinyl alcohol tubes is that they do not possess adequate thermal or chemical resistance for many automotive applications. As a result, these materials may degrade and malfunction under

extreme elevated temperatures or prolonged exposure to elevated temperatures. Fluoropolymers generally provide better thermal resistance than polyamide and ethylene vinyl alcohol, but are more expensive and more difficult to process.

[6] Accordingly, a polyphthalamide tube that overcomes the drawbacks of prior tubing and can be used in automotive elevated temperature and chemical environments is needed.

BRIEF DESCRIPTION OF THE DRAWINGS

[7] Figure 1 schematically illustrates an automobile;

[8] Figure 2 schematically illustrates a cross sectional view of a first embodiment of the present invention including a single layer of polyphthalamide;

[9] Figure 3 schematically illustrates a cross sectional view of a second embodiment of the present invention including two layers;

[10] Figure 4 schematically illustrates a cross sectional view of a third embodiment of the present invention including three layers; and

[11] Figure 5 schematically illustrates a cross sectional view of a fourth embodiment of the present invention including corrugations.

[12] Figure 6 schematically illustrates a cross sectional view of a fifth embodiment of the present invention including corrugations.

DETAILED DESCRIPTION OF THE PREFFERRED EMBODIMENT

[13] Figure 1 illustrates an automobile 10 including an automobile system 12 utilizing tube 14. The automobile system 12 can be an engine cooling system, an air conditioning system, a transmission oil cooling system, a fuel system, or a vacuum brake system. However, it is to be understood that this list of automobile systems is non-exclusive and other types of

automobile systems can be utilized. The tube 14 operates under a variety of conditions in the automobile system 12, including contact with chemicals (i.e. automotive fluids) and/or exposure to elevated temperatures.

[14] The primary function of the tube 14 is to carry and transport an automotive fluid in the automobile system 12. In order to function properly over the lifetime of the automobile 10, the tube 14 must be chemically resistant to the automotive fluids and thermally resistant to the elevated temperatures.

[15] The tube 14 of the present invention is formed from polyphthalamide, an aromatic or semi-aromatic polyamide thermoplastic material. Polyphthalamide has superior temperature and chemical resistance compared to polyamide and ethylene vinyl alcohol. Polyphthalamide is less expensive than many fluoropolymers. Although polyphthalamide is disclosed, it is to be understood that any aromatic or semi-aromatic polyamide can be employed.

[16] In one example, Zytel HTN (High Temperature Nylon), available from DuPont (Wilmington, DE), is used to form the tube 14. In another example, polyamide 6T, available from Solvay Engineered Polymers (Auburn Hills, MI), is used to form the tube 14. Polyamide 9T can also be used. It should be understood, however, that alternative sources of aromatic or semi-aromatic polyamide may be used in the present invention.

[17] Figure 2 shows a first embodiment of a tube 22 of the present invention formed from a single layer of polyphthalamide 23 having an inner surface 26 and outer surface 28. The inner surface 26 defines a conduit 30 through which an automotive fluid may be carried and transferred.

[18] The tube 22 may also include a filler or modifier 32 to enhance the performance of the tube 22 and form a polyphthalamide composite. The preferred fillers or modifiers 32 include carbon powder, carbon fiber, metallic fiber, glass fiber, mica and mixtures thereof. However, one of ordinary skill in the art who has the benefit of this disclosure would recognize the

benefits of using other filler or modifiers in the tube 22. The fillers or modifiers 32 enhance the electrical conductivity, strength, impact resistance, elongation, and/or temperature resistance of the tube 22.

[19] Figure 3 shows a second embodiment of a tube 40 of the present invention including an inner layer 42 and an outer layer 44. The inner layer 42 includes an inner surface 46 defining a conduit 48 through which an automotive fluid may be carried and transferred. The inner layer 42 includes an outer surface 49 that contacts an inner surface 50 of the outer layer 44.

[20] At least one of the outer layer 44 and the inner layer 42 is made of polyphthalamide. The layer that is not polyphthalamide is made of other thermoplastic material including, for example, polyvinylidene fluoride, ethylene chlorotrifluoroethylene, ethylene tetrafluoroethylene, polyamide, modified polyamide, polyolefin, ethylene vinyl alcohol, polyester, polybutylene napthalate , other thermoplastic, or combinations thereof. Preferably the outer layer 44 is made of polyphthalamide, and the inner layer 42 is made of another thermoplastic material. However, it is to be understood that both the inner layer 42 and outer layer 44 can be made of polyphthalamide.

[21] The inner layer 42 can be made of a composite of polyphthalamide and fillers or modifiers 32. Example fillers or modifiers 32 used to form the polyphthalamide composite include carbon powder, carbon fiber, metallic fiber, glass fiber, and mica and mixtures thereof. However, one of ordinary skill in the art who has the benefit of this disclosure would recognize the benefits of using other filler or modifiers in the tube 40. The fillers or modifiers 32 can enhance the electrical conductivity, strength, impact resistance, elongation, and/or temperature resistance of the tube 40. The outer layer 44 can also be made of a composite of polyphthalamide and fillers or modifier 32.

[22] In one preferred example, the fillers or modifiers 32 are used to enhance the electrical conductivity of the inner layer 42. In an automobile system 12 (referring back to Figure 1) that includes fuel, electrical conductivity and dissipation of static electricity is a desired feature. Desirable fillers or modifiers 32 for enhancing the electrical conductivity of the tube 40 include carbon powder, carbon fiber, metallic fiber and mixtures thereof added in effective amounts to the polyphthalamide material. The amount of fillers or modifiers 32 must be sufficient to change a characteristic of the polyphthalamide composite compared to the polyphthalamide without any fillers or modifiers 32. In one example, carbon black is added to polyphthalamide to change the electrical conductivity of the polyphthalamide layer.

[23] The outer layer 44 and inner layer 42 are formed by a known co-extrusion process. One of ordinary skill in the art would recognize the skills necessary for co-extruding the tube 40 wherein at least one layer is made of polyphthalamide.

[24] Figure 4 shows a third embodiment of a tube 62 according to the present invention including an outer layer 64, an inner layer 66 disposed inside the outer layer 64, and a middle layer 68 interposed between the inner layer 66 and the outer layer 64. The inner surface 70 of the inner layer 66 defines a conduit 72 through which an automotive fluid may be carried and transported. The middle layer 68 acts as an adhesive to bond an inner surface 74 of the outer layer 64 to an outer surface 76 of the inner layer 66.

[25] At least one of the outer layer 64, the inner layer 66, and the middle layer 68 is made of polyphthalamide. The layers that are not polyphthalamide may be made of other thermoplastic material including, for example, polyvinylidene fluoride, ethylene chlorotrifluoroethylene, ethylene tetrafluoroethylene, polyamide, modified polyamide, polyolefin, ethylene vinyl alcohol, polyester, polybutylene napthalate, other thermoplastic, or combinations thereof. In one example, the outer layer 64 is made of polyphthalamide and the inner layer 66 and middle layer 68 are made of another thermoplastic material. However, it is

to be understood that the middle layer 68 and/or the outer layer 64 may be made of polyphthalamide also.

[26] The inner layer 66 can be made of a composite of polyphthalamide and fillers or modifiers 32. The preferred fillers or modifiers 32 used to form the polyphthalamide composite include carbon powder, carbon fiber, metallic fiber, glass fiber, and mica and mixtures thereof. However, one of ordinary skill in the art who has the benefit of this disclosure would recognize the benefits of using other filler or modifiers in the tube 62. The fillers or modifiers 32 can enhance the electrical conductivity, strength, impact resistance, elongation, and/or temperature resistance of tube 62. It is to be understood that the outer layer 64 and middle layer 68 may also be made of a polyphthalamide composite.

[27] Preferably, fillers or modifiers 32 are used to enhance the electrical conductivity of the tube 62. Desirable fillers or modifiers 32 for enhancing the electrical conductivity include carbon powder, carbon fiber, metallic fiber and mixtures thereof added in effective amounts to the polyphthalamide material. The amount of fillers or modifiers 32 must be sufficient to change a characteristic of the polyphthalamide composite compared to the polyphthalamide without any fillers or modifiers 32.

[28] The outer layer 64, the inner layer 66 and the middle layer 68 are formed by a known co-extrusion process. One of ordinary skill in the art would recognize the skills necessary for co-extruding a three layer polyphthalamide tube 62 wherein at least one layer is made of polyphthalamide.

[29] Figure 5 illustrates a polyphthalamide tube 86 according to the present invention including a corrugated portion 88 having at least one corrugation 90 that provides flexibility. The corrugation 90 generally has a U-shape, although other shapes are possible, and includes a height 92, a length 94, a radius 96 and a thickness 98. In this example, the corrugation 90 extends through the entire thickness 98 of the tube 86. That is, the inner surface 100 is

substantially parallel to the outer surface 102. One of ordinary skill in the art who has the benefit of this disclosure would recognize the benefits of utilizing a corrugation that does not have parallel inner and outer surfaces such as shown in Figure 6 for example. It is to be understood also that the tube 14 may include corrugated portions 88 and non-corrugated portions. That is, the entire length of the tube 14 can include corrugations 88, or alternately, only portions of the length of the tube 86 include corrugations 88.

[30] Figure 6 illustrates a polyphthalamide tube 112 according to the present invention including a corrugated portion 114 having at least one corrugation 116 that provides flexibility. The corrugation 116 generally has a U-shape, although other shapes are possible, and includes a height 118, a length 120, a radius 122 and a thickness 124. In this example, the corrugation 116 does not extend through the entire thickness 124 of the tube 112. That is, the inner surface 126 is not parallel to the outer surface 128. One of ordinary skill in the art who has the benefit of this disclosure would recognize the benefits of utilizing other non-parallel inner and outer surfaces. It is to be understood also that the tube 14 may include corrugated portions 114 and non-corrugated portions. That is, the entire length of the tube 112 can include corrugations 116, or alternately, only portions of the length of the tube 112 include corrugations 116.

[31] The corrugated portions 86, 114 formed from polyphthalamide are particularly advantageous in automotive systems 12 (referring back to Figure 1) that require flexibility to, for example, assemble or bend the tube 86 around an obstacle in the automobile 10.

[32] There are several advantages to the polyphthalamide tube of the present invention. For one, the tube provides chemical and temperature resistance and can withstand the underhood environment of an automobile. The tube can also be less expensive and lighter in weight than rubber tubes. The tube is also recyclable.

[33] The invention has been described in an illustrative manner, and it is to be understood that the terminology used is intended to be in the nature of words of description rather than of limitation. Various modifications and variations of the disclosed examples are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

CLAIMS

We claim:

1. An automotive tube comprising:

at least one layer of aromatic polyamide, semi-aromatic polyamide, or polyphthalamide, and the tube defines a fluid conduit.

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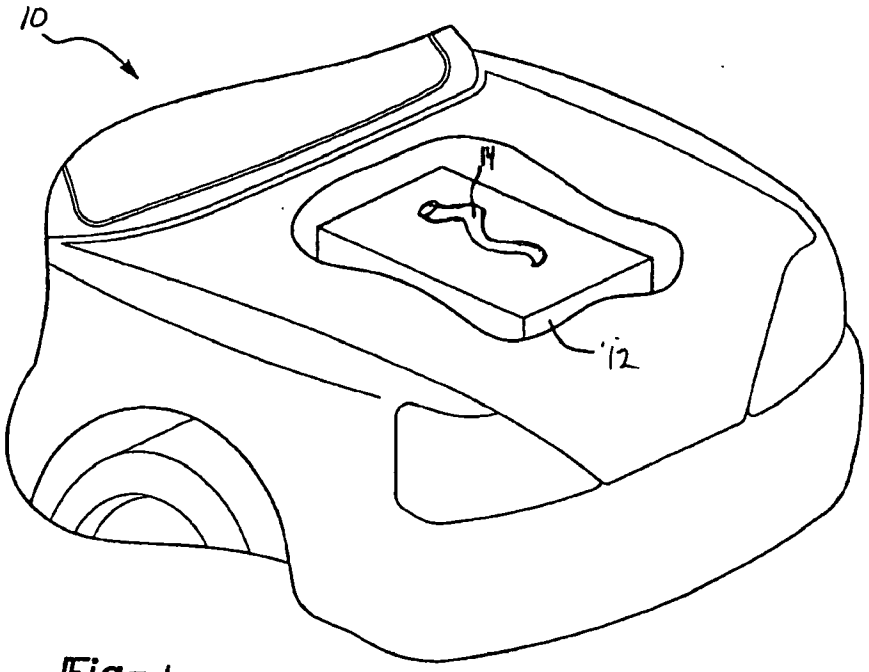

Fig-1

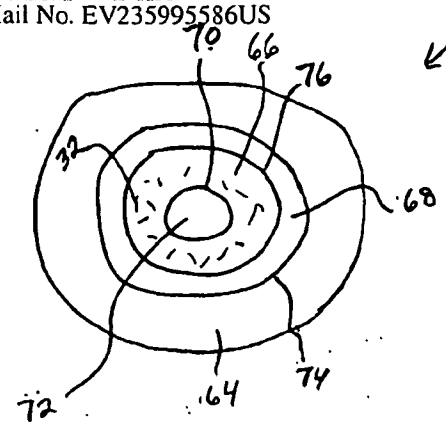

Fig 4

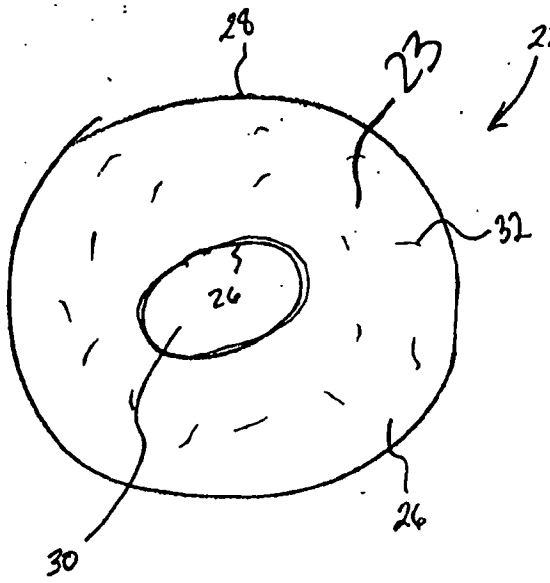

Fig 2

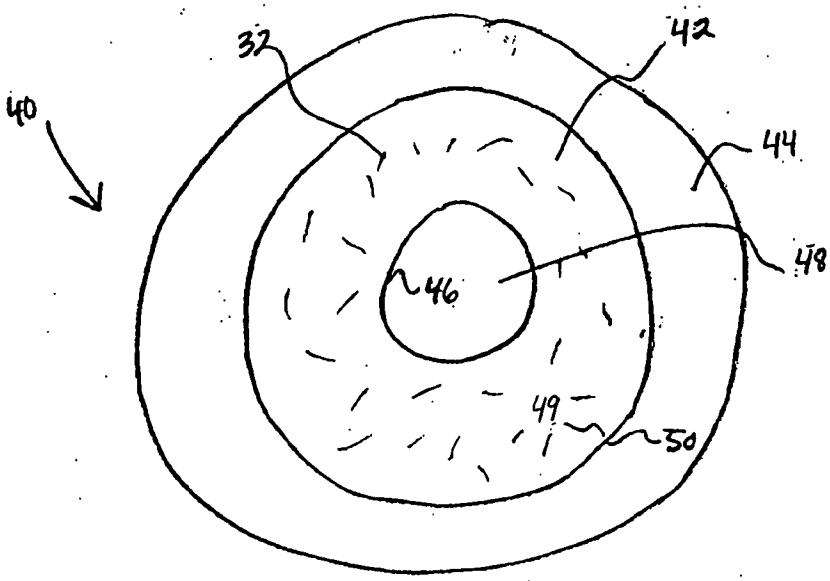

Fig 3

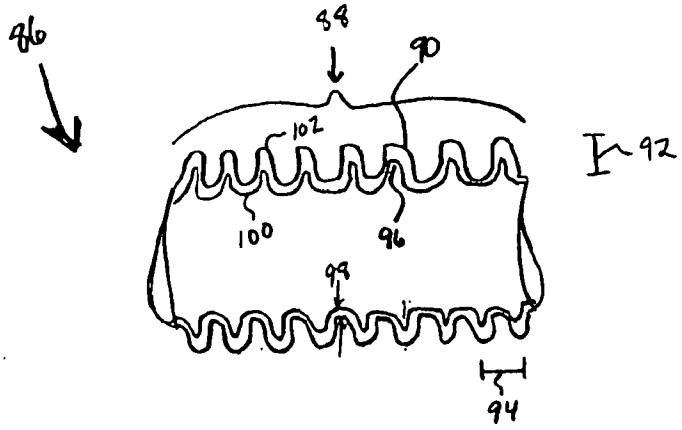

Fig. 5

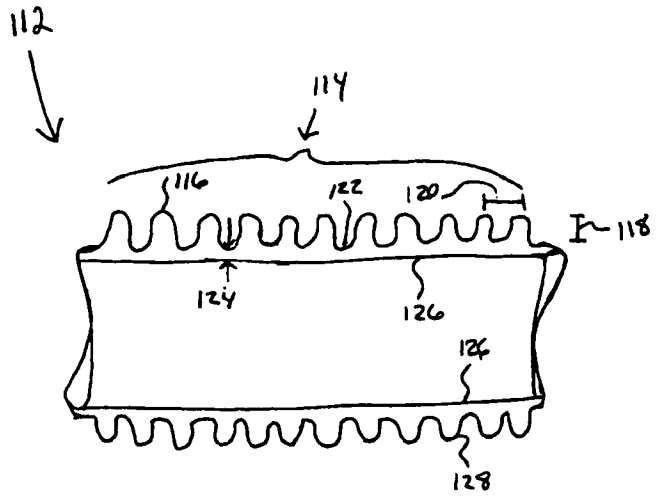

Fig. 6